PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-273915
(43)Date of publication of application : 05.10.2001

(51)Int.Cl. H01M 8/04

(21)Application number : 2000-088929
(22)Date of filing : 28.03.2000

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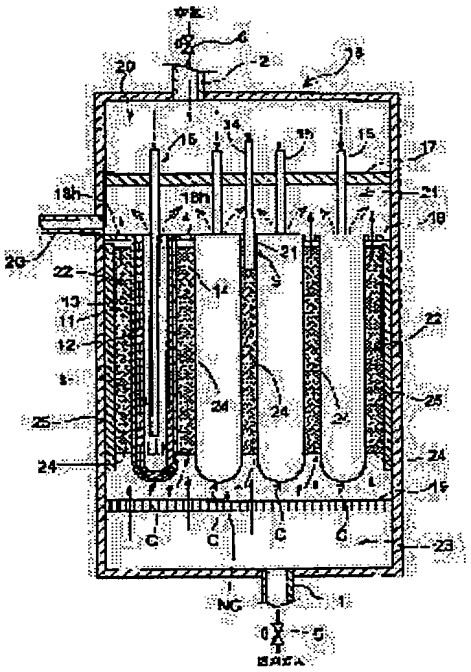
(54) FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell that can improve the generating efficiency while controlling deterioration of power generation performance of the fuel cell.
SOLUTION: This is a fuel cell with a plurality of cells C equipped with an oxygen electrode 12 on one face of an electrolyte layer 11 and a fuel electrode 13 on the other face of it, and which are juxtaposed with each other with the state of being equipped with an oxygen electrode side duct s on the side of the oxygen electrode 12 and with a fuel electrode side duct f on the side of the fuel electrode 13, possessing a supplied gas amount regulating means 5 of fuel electrode side to regulate the amount of gas supplied on the fuel electrode side toward the fuel electrode side duct f. This fuel cell is also equipped with a controlling means to control the supplied gas amount regulating means 5 of fuel electrode side in a way to increase the amount of gas supplied on the fuel electrode side accordingly with the increase in the detected oxygen concentration, based on an oxygen concentration detection means S to detect the oxygen concentration in the fuel electrode side gas conducting through the downstream sector within the fuel electrode side duct f or the oxygen concentration in the fuel electrode side gas drained from the fuel electrode side duct f, and on the oxygen concentration detected by the above oxygen concentration detection means S.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2001－273915
（Ｐ２００１－２７３９１５Ａ）
(43)公開日　平成13年10月５日(2001.10.5)

(51)Int.Cl.[7]	識別記号	ＦＩ	ﾃｰﾏｺｰﾄﾞ（参考）
H01M 8/04		H01M 8/04	J 5H027

審査請求　未請求　請求項の数２　ＯＬ　（全10頁）

(21)出願番号　特願2000－88929(Ｐ2000－88929)

(22)出願日　平成12年３月28日(2000.3.28)

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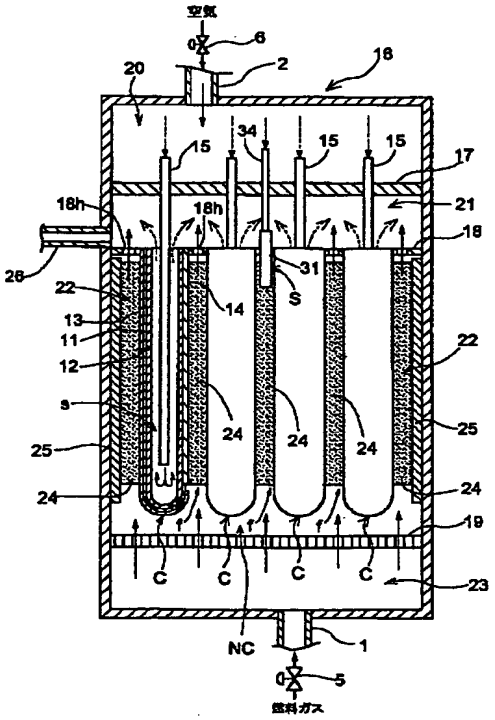
(54)【発明の名称】燃料電池

(57)【要約】
【課題】　セルの発電性能の劣化を抑制しながら、発電効率を向上し得る燃料電池を提供する。
【解決手段】　電解質層１１の一方の面に酸素極１２を備え且つ他方の面に燃料極１３を備えたセルＣの複数が、酸素極１２側に酸素極側流路ｓを備え、且つ、燃料極１３側に燃料極側流路ｆを備える状態で並置され、燃料極側流路ｆへの燃料極側ガス供給量を調節する燃料極側ガス供給量調節手段５が設けられた燃料電池であって、燃料極側流路ｆ中における下流部分を通流する燃料極側ガスにおける酸素濃度、又は、燃料極側流路ｆから排出された燃料極側ガスにおける酸素濃度を検出する酸素濃度検出手段Ｓと、その酸素濃度検出手段Ｓの検出酸素濃度に基づいて、検出酸素濃度が高くなるほど燃料極側ガス供給量が多くなるように、燃料極側ガス供給量調節手段５を制御する制御手段が設けられている。



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【特許請求の範囲】

【請求項１】　電解質層の一方の面に酸素極を備え且つ他方の面に燃料極を備えたセルの複数が、前記酸素極側に酸素極側流路を備え、且つ、前記燃料極側に燃料極側流路を備える状態で並置され、

前記酸素極側流路に酸素を含有する酸素極側ガスを通流させ、且つ、前記燃料極側流路に水素を含有する燃料極側ガスを通流させて発電するように構成され、

前記燃料極側流路への燃料極側ガス供給量を調節する燃料極側ガス供給量調節手段が設けられた燃料電池であって、

前記燃料極側流路中における下流部分を通流する燃料極側ガスにおける酸素濃度、又は、前記燃料極側流路から排出された燃料極側ガスにおける酸素濃度を検出する酸素濃度検出手段と、

その酸素濃度検出手段の検出酸素濃度に基づいて、検出酸素濃度が高くなるほど燃料極側ガス供給量が多くなるように、前記燃料極側ガス供給量調節手段を制御する制御手段が設けられている燃料電池。

【請求項２】　複数の前記セルが前記酸素極側に酸素極側流路を備え且つ前記燃料極側に燃料極側流路を備える状態で並置されて構成されたセル集合体が、複数設けられ、

前記セル集合体毎に前記燃料極側流路への燃料極側ガス供給量を調節すべく、前記燃料ガス供給量調節手段が、前記セル集合体夫々に対して設けられ、

前記酸素濃度検出手段が、前記セル集合体夫々に対して設けられ、

前記制御手段は、前記セル集合体毎に、前記酸素濃度検出手段の検出酸素濃度に基づく前記燃料極側ガス供給量調節手段の制御を実行するように構成されている請求項１記載の燃料電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電解質層の一方の面に酸素極を備え且つ他方の面に燃料極を備えたセルの複数が、前記酸素極側に酸素極側流路を備え、且つ、前記燃料極側に燃料極側流路を備える状態で並置され、前記酸素極側流路に酸素を含有する酸素極側ガスを通流させ、且つ、前記燃料極側流路に水素を含有する燃料極側ガスを通流させて発電するように構成され、前記燃料極側流路への燃料極側ガス供給量を調節する燃料極側ガス供給量調節手段が設けられた燃料電池に関する。

【０００２】

【従来の技術】かかる燃料電池は、電解質層の一方の面に酸素極を備え且つ他方の面に燃料極を備えたセルの複数を、酸素極側に酸素極側流路を備え、且つ、燃料極側に燃料極側流路を備える状態で並置して、セル集合体を構成し、酸素極側流路に酸素を含有する酸素極側ガスを通流させ、且つ、燃料極側流路に水素を含有する燃料極側ガスを通流させて、各セルで発電させることにより、セル集合体から発電電力を出力するものである。

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【０００３】従来は、セル集合体の発電電流に応じて、燃料極側流路への燃料極側ガス供給量を、発電電流が多くなるほどガス供給量が多くなるように、設定燃料極側ガス供給量として予め設定しておき、セル集合体の発電電流を検出して、その検出発電電流に応じた設定燃料極側ガス供給量になるように、制御手段によって、燃料極側ガス供給量調節手段を制御するように構成していた。

【０００４】

【発明が解決しようとする課題】ところで、セルに供給された水素の全量に対する、反応で使われた水素の量の割合にて示される燃料利用率は、高いほど発電効率が高くなるが、高くなり過ぎると、セルの発電性能が劣化するという問題が生じる。例えば、固体電解質層を用いた固体電解質型のセルでは、燃料極に、ニッケルとＹＳＺ（Ｙ；Ｏ；安定化ＺｒＯ；）のサーメットを用いるが、燃料利用率が高くなり過ぎると、燃料極が酸化して微構造が変化するため、セルの発電性能が劣化する。

【０００５】一方、燃料電池は、運転時間が経過するに伴って、セルにおいて酸素含有ガスが酸素極側から燃料極側へ漏れる現象（以下、酸素洩れと記載する場合が有る）が起こる場合がある。

【０００６】酸素漏れが起こったセルでは、燃料極側流路を通流する燃料極側ガス中の水素含有率が低くなる。従って、従来のように燃料極側流路への燃料極側ガス供給量を検出発電電流に応じた設定燃料極側ガス供給量になるように一義的に調節する場合は、酸素漏れが起こったセルでは、燃料利用率が初期設定よりも高くなることになる。そこで、従来は、運転時間の経過に伴って、一部のセルに酸素漏れが起こって燃料利用率が高くなったとしても、その燃料利用率がセルが劣化する程度にまで高くならないように、設定燃料極側ガス供給量は、予め余裕を見て多めに設定していた。従って、従来の燃料電池では、発電効率が低いという問題があった。

【０００７】本発明は、かかる実情に鑑みてなされたものであり、その目的は、セルの発電性能の劣化を抑制しながら、発電効率を向上し得る燃料電池を提供することにある。

【０００８】

【課題を解決するための手段】〔請求項１記載の発明〕請求項１に記載の特徴構成は、前記燃料極側流路中における下流部分を通流する燃料極側ガスにおける酸素濃度、又は、前記燃料極側流路から排出された燃料極側ガスにおける酸素濃度を検出する酸素濃度検出手段と、その酸素濃度検出手段の検出酸素濃度に基づいて、検出酸素濃度が高くなるほど燃料極側ガス供給量が多くなるように、前記燃料極側ガス供給量調節手段を制御する制御手段が設けられていることにある。請求項１に記載の特徴構成によれば、一部のセルにおいて酸素漏れが起こる

と、燃料極側流路中における下流部分を通流する燃料極側ガスにおける酸素濃度、又は、燃料極側流路から排出された燃料極側ガスにおける酸素濃度が高くなるため、酸素濃度検出手段の検出酸素濃度が高くなることにより、制御手段によって、燃料極側ガス供給量が多くなるように、燃料極側ガス供給量調節手段が制御されて、燃料利用率が低くなるように調節されるので、酸素漏れに起因するセルの劣化を防止することができる。つまり、予め、発電電流に応じて、設定燃料極側ガス供給量を設定しておいて、検出発電電流に応じた設定燃料極側ガス供給量を、検出酸素濃度に応じて増減補正するようにすると、設定燃料極側ガス供給量を、従来の如き予め余裕を見た多めの値とする必要がなく、セルを劣化させることがない範囲で、できるだけ少なく設定することができる。従って、セルの発電性能の劣化を抑制しながら、従来よりも高い燃料利用率で運転することが可能となり、発電効率を向上することができるようになった。

【０００９】〔請求項２記載の発明〕請求項２に記載の特徴構成は、複数の前記セルが前記酸素極側に酸素極側流路を備え且つ前記燃料極側に燃料極側流路を備える状態で並置されて構成されたセル集合体が、複数設けられ、前記セル集合体毎に前記燃料極側流路への燃料極側ガス供給量を調節すべく、前記燃料ガス供給量調節手段が、前記セル集合体夫々に対して設けられ、前記酸素濃度検出手段が、前記セル集合体夫々に対して設けられ、前記制御手段は、前記セル集合体毎に、前記酸素濃度検出手段の検出酸素濃度に基づく前記燃料極側ガス供給量調節手段の制御を実行するように構成されていることにある。請求項２に記載の特徴構成によれば、燃料電池を構成する複数のセルを用いて、複数のセル集合体が構成され、セル集合体毎に、酸素濃度検出手段の検出酸素濃度に基づく燃料極側ガス供給量調節手段の制御が実行されるので、セル集合体毎に、セルの発電性能の劣化を抑制する状態で、可及的に高い燃料利用率で運転させることができる。従って、燃料電池を構成する全てのセルを１個のセル集合体に構成して、１個のセル集合体にて、酸素濃度検出手段の検出酸素濃度に基づく燃料極側ガス供給量調節手段の制御を実行する場合に比べて、燃料電池全体としての燃料利用率を効果的に高くして運転することができるので、セルの発電性能の劣化を抑制しながら、発電効率を更に向上することができるようになった。

【００１０】

【発明の実施の形態】〔第１実施形態〕以下、図１ないし図４に基づいて、本発明の第１の実施の形態を、円筒型の固体電解質型セルを用いた燃料電池に適用した場合について説明する。図１に示すように、燃料電池は、１個のセル集合体ＮＣを備えた燃料電池発電部ＥＧを設け、そのセル集合体ＮＣに、燃料ガス供給路１を通じて燃料極側ガスとして水素を含有する燃料ガスを供給し、

並びに、空気供給路２を通じて酸素極側ガスとして送風機３からの空気を供給して、電力出力路４から、セル集合体ＮＣにて発電された直流電力を出力するように構成してある。

【００１１】燃料ガス供給路１には、セル集合体ＮＣへの燃料ガス供給量を調節する燃料ガス供給量調節弁５を設け、空気供給路２には、セル集合体ＮＣへの空気供給量を調節する空気供給量調節弁６を設け、電力出力路４には、セル集合体ＮＣからの発電電流を検出する電流検出器７を設け、その電流検出器７の検出発電電流に基づいて、燃料ガス供給量調節弁５及び空気供給量調節弁６夫々を制御する制御部８を設けてある。

【００１２】図２及び図３に基づいて、発電部ＥＧについて説明を加える。燃料電池のセルＣは、一端を閉塞した円筒状の酸素極１２（以下、酸素極チューブと称する場合が有る）を構造支持体として、その酸素極チューブ１２の外周部に、固体電解質層１１とインターコネクタ１４とを設け、固体電解質層１１の外周部に燃料極１３をインターコネクタ１４と非接触状態で設けて、一端側が閉塞した円筒型に形成してある。セルＣの円筒内部を酸素極側流路ｓとして機能させ、その酸素極側流路ｓに空気を供給する空気導入管１５を円筒内部に挿入した状態で設けてある。

【００１３】インターコネクタ１４は、酸素極チューブ１２の外周部に、その軸芯方向に沿う細長形状に設け、固体電解質層１１は、酸素極チューブ１２の外周部におけるインターコネクタ１４が設けられた残りの部分に設けてある。

【００１４】固体電解質層１１はＹＳＺ、酸素極チューブ１２は$LaMnO_3$、燃料極１３はＮｉとZrO_2のサーメット、インターコネクタ１４は$LaCrO_3$から夫々成る。

【００１５】箱体１６の内部を、２枚の隔壁１７，１８及び１枚の多孔状の分散板１９により、空気供給室２０、燃焼室２１、発電室２２、燃料ガス供給室２３を、記載順に上から下に向かって並ぶように区画形成してある。

【００１６】そして、複数の円筒型のセルＣを、夫々の酸素極チューブ１２の開口端を燃焼室２１に臨ませた状態でその燃焼室２１と発電室２２を区画する隔壁１８にて支持する状態で、発電室２２内に、互いに間隔を隔てて格子状に並置すると共に、図３において、上下方向に並ぶセルＣは、隣接するセルＣ間に、気体の通流を許容する状態に形成した柔軟性導電材２４を隣接する燃料極１３同士に接触させる状態で設けることにより、電気的に並列接続し、並びに、左右方向に並ぶセルＣは、隣接するセルＣ間に、柔軟性導電材２４を隣接するインターコネクタ１４と燃料極１３とに接触させる状態で設けることにより、電気的に直列接続して、セル集合体ＮＣを形成してある。燃焼室２１と発電室２２を区画する隔壁

１８には、燃焼室２１と発電室２２とを連通する通気孔１８ｈを多数形成してある。

【００１７】直列接続方向に並ぶセル列の一端側には、その端部のセルＣ夫々の燃料極１３に柔軟性導電材２４にて導電状態に接続される状態で、集電板２５を設け、直列接続方向に並ぶセル列の他端側には、その端部のセルＣ夫々のインターコネクタ１４と柔軟性導電材２４にて導電状態に接続される状態で、集電板２５を設け、それら一対の集電板２５により、セル集合体ＮＣから発電電力を取り出すように構成してある。柔軟性導電材２４は、ニッケルのフェルト状材から成る。

【００１８】各セルＣの空気導入管１５は、空気供給室２０と燃焼室２１とを区画する隔壁１７を貫通して、開口端が空気供給室２０内に位置するように設けてある。そして、燃料ガス供給室２３に燃料ガス供給路１を接続し、空気供給室２０に空気供給路２を接続し、燃焼室２１には、排ガス路２６を接続してある。電力出力路４は、一対の集電板２５に接続してある。

【００１９】従って、燃料ガス供給路１から燃料ガス供給室２３に供給された燃料ガスは、分散板１９にて分散される状態で発電室２２に流入し、発電室２２内のセルＣ間を各セルＣの燃料極１３に接触する状態で、燃焼室２１の方に向かって流れて、隔壁１８の通気孔１８ｈを通過して、燃焼室２１に流入する。従って、発電室２２内が、燃料極側流路ｆとして機能し、発電室２２内において燃焼室２１側の端部が、燃料極側流路ｆ中における下流部分に相当する。一方、空気供給路２から空気供給室２０に供給された空気は、各セルＣの空気導入管１５を通じて、各セルＣの円筒内部の酸素極側流路ｓに流入して、酸素極側流路ｓを酸素極１２に接触する状態で流れて、円筒開口端から燃焼室２１に流入する。そして、燃焼室２１に流入した燃料ガスと空気とは燃焼室２１内で燃焼し、その燃焼ガスが排ガス路２６を通じて排出される。セル集合体ＮＣにて発電された電力は、電力出力路４を通じて出力される。

【００２０】本発明においては、燃料極側流路ｆ中における下流側部分、換言すれば、発電室２２内における燃焼室２１側の端部を通流する燃料ガスにおける酸素濃度を検出する酸素濃度検出手段としての酸素センサＳを設けてある。

【００２１】酸素センサＳは、図４に示すように、一端が閉塞したＹＳＺ製のセンサチューブ３１を構造支持体として、そのセンサチューブ３１の閉塞端内周面に多孔状の内側電極３２を付設し、閉塞端外周面に多孔状の外側電極３３を付設して検出部分を形成すると共に、センサチューブ３１内に空気を供給する空気供給管３４、及び、センサチューブ３１内の検出する温度センサ３５夫々を、センサチューブ３１内に挿入して構成してある。更に、電極３２，３３夫々には電圧取り出し用のリード線３６を接続してある。尚、内側電極３２は白金から成り、外側電極３３は、ニッケルとＹＳＺのサーメットから成る。

【００２２】そして、図２に示すように、上述のように構成した酸素センサＳを、センサチューブ３１の閉塞端の検出部分が燃料極側流路ｆ中における下流側部分に位置し、空気供給管３４の開口端が空気供給室２０内に位置するように設けてある。

【００２３】ＹＳＺは５００°Ｃ以上の高温になると、酸素イオン導電体となるが、固体電解質型の燃料電池の作動温度は８００～１０００°Ｃ程度であり、酸素センサＳを上述のように設けると、センサチューブ３１は前記作動温度と同程度の高温に加熱されることになるので、センサチューブ３１を構成するＹＳＺは酸素イオン導電体となる。そして、センサチューブ３１内は空気雰囲気となり、センサチューブ３１外の外側電極３３が付設された部分は、燃料極側流路ｆ中における下流側部分を流れる燃料ガスに晒されるので、チューブ内外で酸素分圧が異なることになり、この系は酸素濃淡電池となり、両電極３２，３３間に起電力を生じる。センサチューブ３１内は酸素濃度が既知である空気であるので、両電極３２，３３間に発生する起電力により、燃料極側流路ｆ中における下流側部分を流れる燃料ガスにおける酸素濃度を求めることができる。尚、酸素センサＳにて燃料ガスにおける酸素濃度を求めるに当たっては、温度センサ３５の検出温度により温度補正して正規化して求める。

【００２４】次に、制御部８の制御動作について説明を加える。図１に示すように、制御部８は、電流検出器７及び酸素センサＳ夫々の検出情報に基づいて、燃料ガス供給量調節弁５及び空気供給量調節弁６夫々を制御する。予め、燃料ガス供給路１にて供給する単位時間当たりの燃料ガス供給量を設定燃料ガス供給量として、及び、空気供給路２にて供給する単位時間当たりの空気供給量を設定空気供給量として、夫々、セル集合体ＮＣの発電電流に応じて設定してある。設定燃料ガス供給量は、例えば、セルＣにおいて酸素極１２側から燃料極１３側への空気の漏れ（即ち、酸素漏れ）がない状態、即ち、酸素センサＳの検出酸素濃度がゼロの状態で、各セルＣにおける燃料利用率が、例えば８５％を維持できるように設定してある。

【００２５】具体的には、制御部８は、酸素センサＳの検出酸素濃度がゼロの場合は、電流検出器７の検出発電電流に応じた設定燃料極側ガス供給量に調節するように、燃料ガス供給量調節弁５を制御し、酸素センサＳの検出酸素濃度がゼロより高くなると、電流検出器７の検出発電電流に応じた設定燃料極側ガス供給量を、検出酸素濃度に応じて、その検出酸素濃度が高くなるほど補正量が多くなるように補正し、その補正した設定燃料極側ガス供給量に調節するように、燃料ガス供給量調節弁５を制御する。例えば、酸素センサＳの検出酸素濃度が５

％となると、前記設定燃料極側ガス供給量を５％多くするように補正する。又、電流検出器７の検出発電電流に応じた設定空気供給量に調節するように、空気供給量調節弁６を制御する。

【００２６】従って、発電室２２内のセルＣの一部に酸素漏れが発生すると、酸素センサＳの検出酸素濃度がゼロより高くなり、その検出酸素濃度に応じて、検出酸素濃度が高くなるほど燃料ガス供給量が多くなるように調節されるので、酸素漏れが起こったセルＣが劣化することはない。従って、設定燃料極側ガス供給量を、従来の如き予め余裕を見た多めの値とする必要がないので、セルＣの発電性能の劣化を防止しながら、従来よりも少ない値に設定することができる。

【００２７】以下、本発明の第２及び第３の各実施形態を説明するが、第１実施形態と同じ構成要素や同じ作用を有する構成要素については、重複説明を避けるために、同じ符号を付すことにより説明を省略し、主として、第１実施形態と異なる構成を説明する。

【００２８】〔第２実施形態〕以下、図５及び図６に基づいて、本発明の第２の実施の形態を、円筒型の固体電解質型セルを用いた燃料電池に適用した場合について説明する。図５に示すように、燃料電池は、複数個のセル集合体ＮＣを備えた燃料電池発電部ＥＧを設け、各セル集合体ＮＣに対して、個別に、燃料ガス供給路１を通じて燃料ガスを供給し、並びに、空気供給路２を通じて空気を供給して、各セル集合体ＮＣから電力出力路４を通じて出力される直流電力を、合流出力路９に合流させて出力するように構成してある。

【００２９】図６に示すように、発電部ＥＧは、第１実施形態と同様にセル集合体ＮＣ等を備えた箱体１６の複数を並置して構成してある。燃料ガス供給路１及び空気供給路２を、各セル集合体ＮＣ毎に、第１実施形態と同様に設け、並びに、電力出力路４も、各セル集合体ＮＣ毎に、第１実施形態と同様に設けてある。

【００３０】各燃料ガス供給路１には燃料ガス供給量調節弁５を、各空気供給路２には空気供給量調節弁６を、各電力出力路４には電流検出器７を夫々、設けてある。又、各セル集合体ＮＣに対して、第１実施形態と同様の酸素センサＳを、第１実施形態と同様に設けてある。

【００３１】制御部８は、電流検出器７の検出発電電流及び酸素センサＳの検出酸素濃度夫々に基づく燃料ガス供給量調節弁５の制御、並びに、電流検出器７の検出発電電流に基づく空気供給量調節弁６の制御を、セル集合体ＮＣ毎に、第１実施形態と同様に実行するように構成してある。従って、セル集合体ＮＣ毎に、セルＣの発電性能の劣化を抑制する状態で、可及的に高い燃料利用率で運転させることができる。

【００３２】〔第３実施形態〕以下、図７ないし図１０に基づいて、本発明の第３の実施の形態を、平板型の固体電解質型セルを用いた燃料電池に適用した場合について説明する。図７に示すように、第３実施形態においては、燃料電池発電部ＥＧ以外は、第１実施形態と同様に構成してある。

【００３３】以下、図８ないし図１０に基づいて、燃料電池発電部ＥＧについて説明する。図８に示すように、セルＣは、平面形状が矩形板状の固体電解質層４１の一方の面に、固体電解質層４１における向かい合う一対の側縁夫々に側縁全長にわたる電解質層露出部４１ａを形成する状態で、膜状又は板状の酸素極４２を一体的に付設し、且つ、他方の面に膜状又は板状の燃料極４３を、全面又はほぼ全面にわたって一体的に付設して、矩形板状に形成してある。

【００３４】そして、セルＣにおける酸素極４２側に、酸素極側流路ｓを形成すべく、導電性セパレータ４４を付設して、矩形板状のセパレータ付セルＣｓを形成してある。説明を加えると、導電性セパレータ４４は、板状部４４ａと、その板状部４４ａの両端に夫々位置する一対の帯状突起部４４ｂと、それら一対の帯状突起部４４ｂの間に位置する複数の凸条部４４ｃを備える状態で導電性材料にて一体形成してある。その導電性セパレータ４４を、複数の凸条部４４ｃ夫々が酸素極４２と接触する状態で、一対の帯状突起部４４ｂ夫々を両電解質層露出部４１ａ夫々に貼り付けることにより、セパレータ付セルＣｓを形成してある。

【００３５】そして、酸素極４２と導電性セパレータ４４とを導電状態に接続するとともに、酸素極４２と導電性セパレータ４４との間に、セパレータ付セルＣｓにおけるセル周縁を形成する４辺のうちの一方の対向する一対の辺に対応するセル周縁部分において開口部ｓｏを備えた酸素極側流路ｓを形成してある。つまり、セパレータ付セルＣは、導電性セパレータ４４によって、セパレータ付セルにおける一方の対向する一対のセル周縁部分が酸素極側流路ｓが開いた開口周縁部分となり、且つ、他方の向かい合う一対の周縁部分が酸素極側流路ｓが閉じた閉塞周縁部分となるように構成してある。

【００３６】固体電解質層４１はＹＳＺ、酸素極４２は$LaMnO_3$、燃料極４３はＮｉとZrO_2のサーメット、導電性セパレータ４４は$LaCrO_3$から夫々成る。

【００３７】そして、図９及び図１０に示すように、複数のセパレータ付セルＣｓを、互いの間に燃料極側流路ｆを形成すべく、間隔を隔てて厚み方向に並置してセル集合体ＮＣを形成する。説明を加えると、セパレータ付セルＣｓにおける一対の閉塞周縁部分の側面夫々に、セパレータ付セルＣｓと同一厚さでセパレータ付セルＣｓより長尺の角柱状の一対の当て付け部材４５を各別に密着させると共に、セパレータ付セルＣｓより長尺の角柱状の一対の間隔保持部材４６を、一対の当て付け部材４５に井桁状に重ねて密着させる状態で、セパレータ付セルＣｓにおける一対の開口周縁部分に各別に密着させ、

更に、それら一対の間隔保持部材４６上に、セパレータ付セルＣｓを載せると共に、一対の当て付け部材４５を井桁状に重ねる状態で、セパレータ付セルＣｓの一対の閉塞周縁部分の側面に各別に密着させるといったことを繰り返すことにより、セパレータ付セルＣｓの複数個を、互いの間に両側を一対の間隔保持部材４６により仕切った燃料極側流路ｆを形成する状態で間隔を隔てて並置して、セル集合体ＮＣを形成してある。そして、セル集合体ＮＣにおける一方の対向する側面部夫々に、一対の間隔保持部材４６，４６と、セル並び方向に隣接する２個の当て付け部材４５，４５とにより、燃料極側流路ｆの開口部ｆｏを形成してある。

【００３８】尚、セパレータ付セルＣｓ間には、気体の通流を許容する状態に形成した柔軟性導電材４７を充填して、その柔軟性導電材４７により、隣合うセパレータ付セルＣＳを電気的に直列接続で接続してある。柔軟性導電材４７は、Ｎｉのフェルト状材にて形成してある。

【００３９】セル集合体ＮＣにおいて、セパレータ付セルＣｓのセル並び方向両端部には、各端部のセパレータ付セルＣｓに導電状態に接続される状態で集電板４８を設け、それら一対の集電板４８によって、セル集合体ＮＣから発電電力を取り出すように構成してある。

【００４０】図１０に示すように、上述のように構成したセル集合体ＮＣにおける４つの側面夫々に、風胴４９を付設し、燃料極側流路ｆの開口部ｆｏが臨む方の一対の風洞４９のうち、一方の内部を燃料ガス供給室５０として、他方の内部を燃料ガス排出室５１として、酸素極側流路ｓの開口部ｓｏが臨む方の一対の風洞４９のうち、一方の内部を空気供給室５２として、他方の内部を空気排出室５３として、夫々用いるように構成してある。

【００４１】そして、図７及び図１０に示すように、燃料ガス供給室５０に燃料ガス供給路１を、燃料ガス排出室５１に燃料ガス排出路５４を、空気供給室５２に空気供給路２を、空気排出室５３に空気排出路５５を夫々接続してある。第１実施形態と同様に、燃料ガス供給路１には燃料ガス供給量調節弁５を、及び、空気供給路２には空気供給量調節弁６を夫々、設けてある。電力出力路４は、一対の集電板４８に接続し、その電力出力路４には、電流検出器７を設けてある。

【００４２】従って、燃料ガス供給路１から燃料ガス供給室５０に供給された燃料ガスは、各燃料極側流路ｆに開口部ｆｏから流入して、各燃料極側流路ｆを燃料極４３に接触する状態で流れて、反対側の開口部ｆｏから燃料ガス排出室５１内に流出して、燃料ガス排出路５４を通じて排出される。一方、空気供給路２から空気供給室５２に供給された空気は、各酸素極側流路ｓに開口部ｓｏから流入して、各酸素極側流路ｓを酸素極４２に接触する状態で流れて、反対側の開口部ｓｏから空気排出室５３内に流出し、空気排出路５５を通じて排出される。

そして、セル集合体ＮＣにて発電された電力は、電力出力路４を通じて出力される。

【００４３】第１実施形態と同様の酸素センサＳを、センサチューブ３１の閉塞端の検出部分が燃料ガス排出室５１内に位置し、空気供給管３４の開口端が燃料ガス排出室５１外に位置するように設けて、酸素センサＳにて、燃料ガス排出室５１内の燃料ガス、換言すれば、燃料極側流路ｆから排出された燃料ガスにおける酸素濃度を検出するように構成してある。尚、燃料ガス排出室５１内には、各燃料極側流路ｆから、燃料電池作動温度と同等の温度の燃料ガスが排出されるので、燃料ガス排出室５１内は、酸素センサＳのＹＳＺが酸素イオン導電体となるに十分な高温となっている。

【００４４】制御部８は、第１実施形態と同様に、電流検出器７の検出発電電流及び酸素センサＳの検出酸素濃度夫々に基づく燃料ガス供給量調節弁５の制御、並びに、電流検出器７の検出発電電流に基づく空気供給量調節弁６の制御を実行する。

【００４５】〔別実施形態〕次に別実施形態を説明する。

（イ）　上記の第１及び第２の各実施形態においては、１個のセル集合体ＮＣに対して、１個の酸素センサＳを設ける場合について例示したが、１個のセル集合体ＮＣに対して、複数個の酸素センサＳを、燃料極側流路ｆ中における下流側部分の各部の酸素濃度を検出できるように、分散させて設けても良い。この場合、最も高い検出酸素濃度に基づいて燃料ガス供給量の増大調節を行うように構成すると、セルＣの酸素漏れを迅速に発見して迅速に対策を講じることができるので、セルＣの発電性能の劣化を一層効果的に防止することができる。

【００４６】（ロ）　第３実施形態において、酸素センサＳを、燃料極側流路ｆ中における下流側部分を通流する燃料ガスの酸素濃度を検出するように設けても良い。

【００４７】（ハ）　上記の実施形態においては、設定燃料ガス供給量は、酸素センサＳの検出酸素濃度がゼロの状態で、各セルＣにおける燃料利用率を設定値（例えば８５％）に維持できるように設定する場合について例示した。これに代えて、設定燃料ガス供給量を、酸素センサＳの検出酸素濃度がゼロより高い設定酸素濃度の状態で、各セルＣにおける燃料利用率を設定値に維持できるように設定しても良い。この場合は、検出酸素濃度が前記設定酸素濃度より低いときは、電流検出器７の検出発電電流に応じた設定燃料極側ガス供給量を、検出酸素濃度に応じて、その検出酸素濃度が低くなるほど減少補正量が多くなるように減少補正することになる。

【００４８】（ニ）　上記の実施形態において例示した固体電解質型の燃料電池では、燃料極側流路ｆ内において、メタンガス等の炭化水素系の原燃料ガスを、水蒸気を用いて水素ガスを含有する燃料ガスに改質処理すること、所謂、内部改質が可能であるので、燃料ガス供給路

１からは、原燃料ガスと水蒸気との混合ガスを供給するようにしても良い。この場合は、燃料ガス供給量調節弁５にて原燃料ガスの供給量を調節することになるが、結果として燃料ガスの供給量を調節することになる。従って、燃料ガス供給量調節弁５にて燃料ガスの供給量を調節することには、燃料ガス供給量調節弁５にて原燃料ガスの供給量を調節することを含むものとする。

【００４９】（ホ）　酸素センサＳの具体構成は、上記の実施形態において例示した構成に限定されるものではない。例えば、ポンピング作用によって酸素イオンをキャリアとする電流がＹＳＺを流れるように、ＹＳＺの両側に電圧を印加して、その電流値に基づいて酸素濃度を検出するように構成しても良い。

【００５０】（ヘ）　本発明は、上記の実施形態において例示した固体電解質型の燃料電池以外に、リン酸型や固体高分子型等、種々の燃料電池に適用することができる。但し、リン酸型や固体高分子型の燃料電池は、夫々の作動温度が、ＹＳＺが酸素イオン導電体となるような高温ではないので、酸素センサＳには、ＹＳＺを酸素イオン導電体となるように加熱するためのヒータを設ける。

【図面の簡単な説明】

【図１】第１実施形態にかかる燃料電池の系統図

【図２】第１実施形態にかかる燃料電池の発電部の縦断側面図

【図３】第１実施形態にかかる燃料電池の発電部の横断平面図

【図４】酸素センサの縦断側面図

【図５】第２実施形態にかかる燃料電池の系統図

【図６】第２実施形態にかかる燃料電池の発電部の縦断側面図

【図７】第３実施形態にかかる燃料電池の系統図

【図８】第３実施形態にかかる燃料電池のセルの斜視図

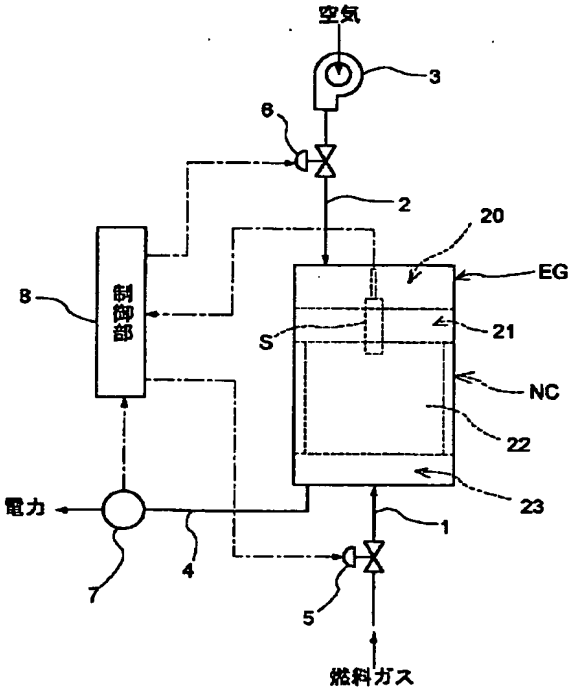
【図９】第３実施形態にかかる燃料電池のセル集合体の分解斜視図

【図１０】第３実施形態にかかる燃料電池の燃料電池発電部の斜視図

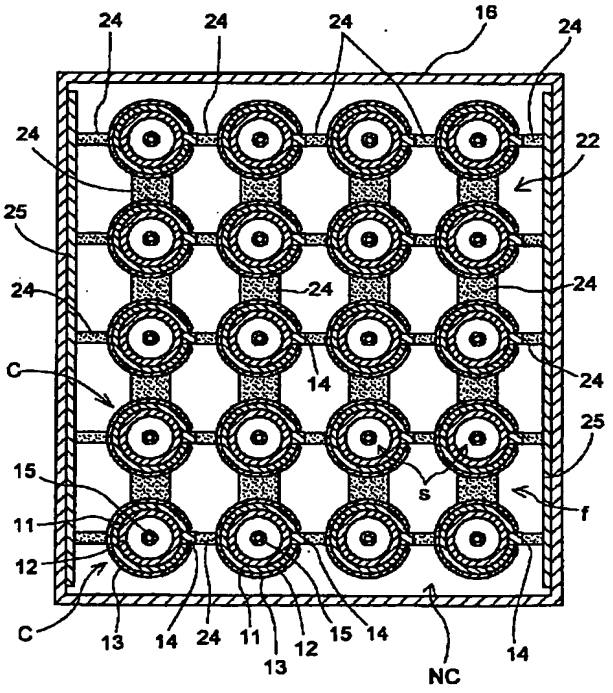
【符号の説明】

5	燃料極側ガス供給量調節手段
8	制御手段
１１，４１	電解質層
１２，４２	酸素極
１３，４３	燃料極
f	燃料極側流路
s	酸素極側流路
C	セル
ＮＣ	セル集合体
S	酸素濃度検出手段

【図１】



【図３】



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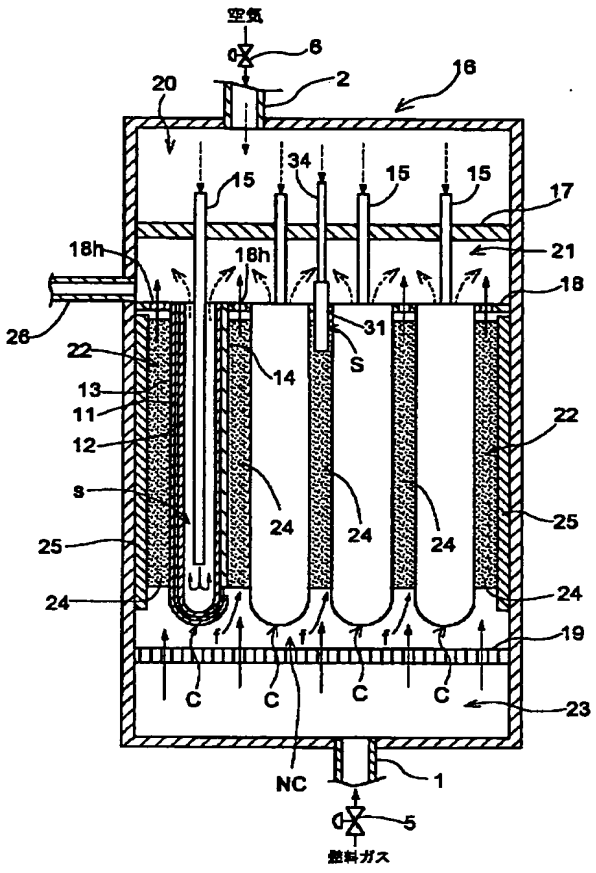
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16
20
15
34
15
15
17
18h
18h
21
18
28
31
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S
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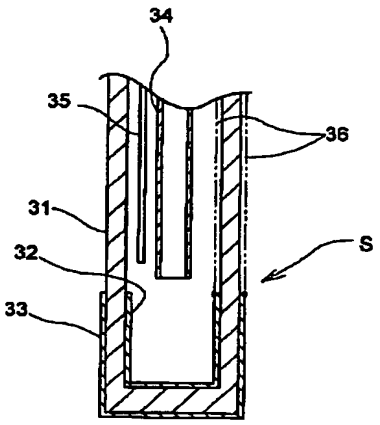
13
11
12
s
22
24
24
24
25
25
24
24
19
C
C
C
C
23
NC
1
5
燃料ガス

【図４】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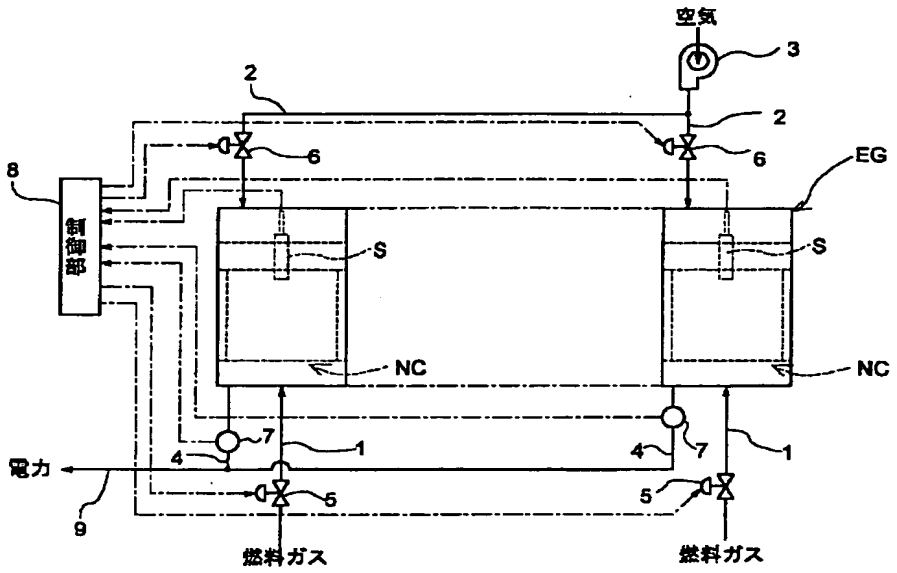
36
31
32
S
33

【図５】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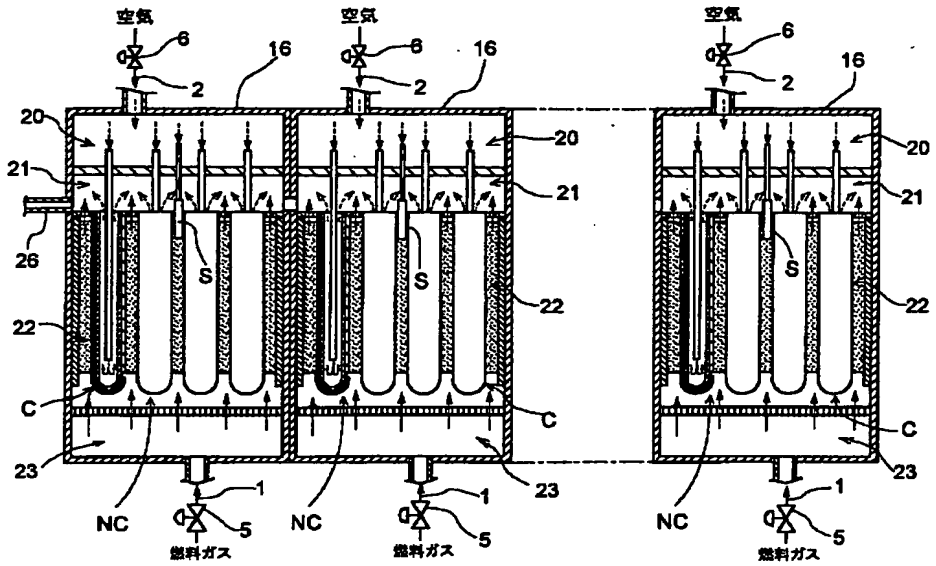
2
6
6
EG
8
制御部
S
S
NC
NC
7
7
1
1
4
4
電力
5
5
9
燃料ガス
燃料ガス

【図６】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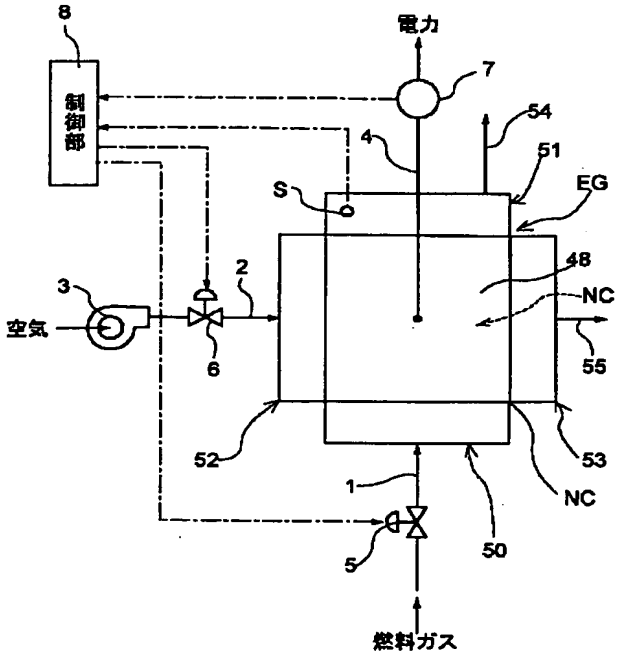
C
23
NC
1
5
燃料ガス

【図７】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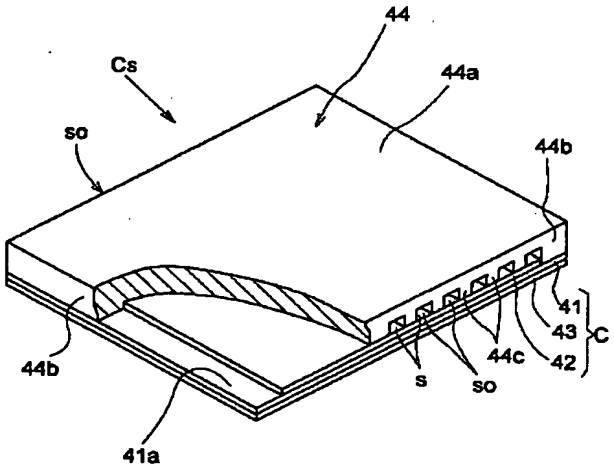
制御部
電力
7
54
4
51
S
EG
48
3
空気
2
6
NC
55
52
53
1
5
50
燃料ガス

【図８】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Cs
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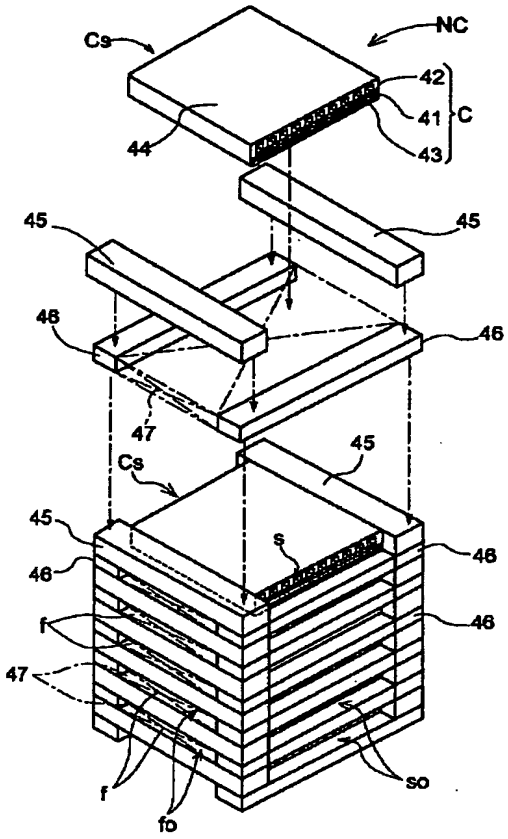
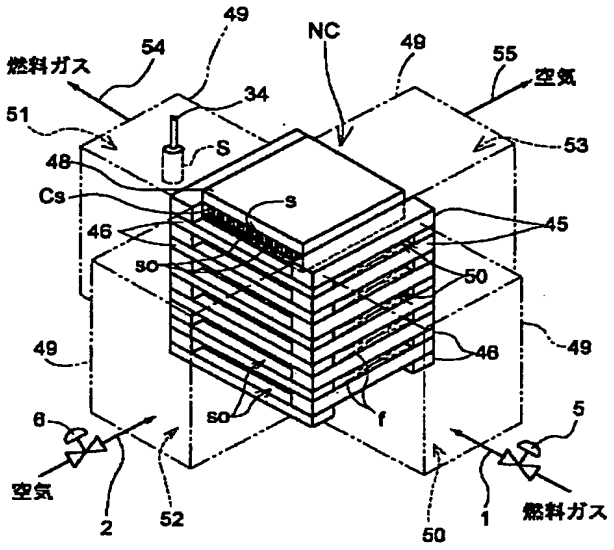
so
44b
41
43
C
42
44c
s
41a

【図９】



【図１０】



フロントページの続き

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Ｆターム(参考)　5H027 AA06 KK31 MM09

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-273915
(43)Date of publication of application : 05.10.2001

(51)Int.Cl. H01M 8/04

(21)Application number : 2000-088929
(22)Date of filing : 28.03.2000

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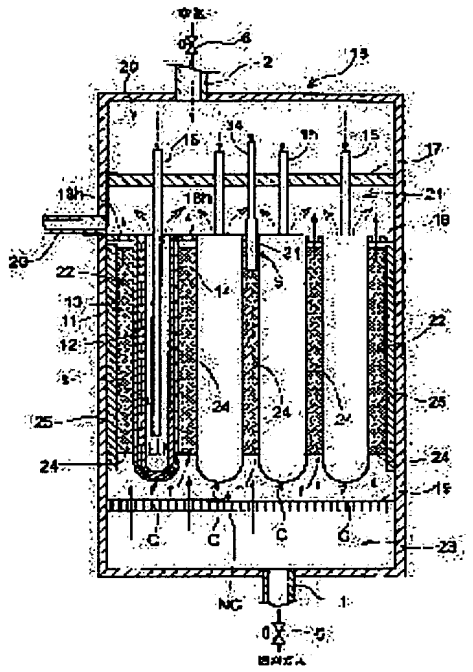
(54) FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell that can improve the generating efficiency while controlling deterioration of power generation performance of the fuel cell.
SOLUTION: This is a fuel cell with a plurality of cells C equipped with an oxygen electrode 12 on one face of an electrolyte layer 11 and a fuel electrode 13 on the other face of it, and which are juxtaposed with each other with the state of being equipped with an oxygen electrode side duct s on the side of the oxygen electrode 12 and with a fuel electrode side duct f on the side of the fuel electrode 13, possessing a supplied gas amount regulating means 5 of fuel electrode side to regulate the amount of gas supplied on the fuel electrode side toward the fuel electrode side duct f. This fuel cell is also equipped with a controlling means to control the supplied gas amount regulating means 5 of fuel electrode side in a way to increase the amount of gas supplied on the fuel electrode side accordingly with the increase in the detected oxygen concentration, based on an oxygen concentration detection means S to detect the oxygen concentration in the fuel electrode side gas conducting through the downstream sector within the fuel electrode side duct f or the oxygen concentration in the fuel electrode side gas drained from the fuel electrode side duct f, and on the oxygen concentration detected by the above oxygen concentration detection means S.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

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CLAIMS

[Claim(s)]
[Claim 1] The plurality of the cel which equipped the field of another side with the fuel electrode in preparation for one field of an electrolyte layer an oxygen pole It is juxtaposed in the condition of equipping said oxygen pole side with an oxygen pole side stream way, and equipping said fuel electrode side with a fuel electrode side stream way. Said oxygen pole side stream way is made to carry out conduction of the oxygen pole side gas containing oxygen. It is constituted so that conduction of the fuel electrode side gas which contains hydrogen on said fuel electrode side stream way may be carried out and it may be generated. It is the fuel cell with which a fuel electrode side gas-supply-volume accommodation means to adjust the fuel electrode side gas supply volume to said fuel electrode side stream way was established. The oxygen density in the fuel electrode side gas which carries out conduction of the part for the downstream in said fuel electrode side stream way, Or so that a detection oxygen density becomes high based on the detection oxygen density of an oxygen density detection means to detect the oxygen density in the discharged fuel electrode side gas, and its oxygen density detection means, from said fuel electrode side stream way and fuel electrode side gas supply volume may increase The fuel cell with which the control means which controls said fuel electrode side gas-supply-volume accommodation means is established.
[Claim 2] The cel aggregate which said two or more cels were juxtaposed in the oxygen pole side stream way in the condition of equipping said fuel electrode side with a fuel electrode side stream way in preparation for said oxygen pole side, and was constituted That more than one are prepared and the fuel electrode side gas supply volume to said fuel electrode side stream way should be adjusted for said every cel aggregate Said fuel gas amount-of-supply accommodation means is established to said each of cel aggregate, and said oxygen density detection means is established to said each of cel aggregate. Said control means The fuel cell according to claim 1 constituted for said every cel aggregate so that control of said fuel electrode side gas-supply-volume accommodation means based on the detection oxygen density of said oxygen density detection means may be performed.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In preparation for one field of an electrolyte layer, as for this invention, the plurality of the cel equipped with the fuel electrode an oxygen pole to the field of another side It is juxtaposed in the condition of equipping said oxygen pole side with an oxygen pole side stream way, and equipping said fuel electrode side with a fuel electrode side stream way. Said oxygen pole side stream way is made to carry out conduction of the oxygen pole side gas containing oxygen. It is constituted so that conduction of the fuel electrode side gas which contains hydrogen on said fuel electrode side stream way may be carried out and it may be generated, and it is related with the fuel cell with which a fuel electrode side gas-supply-volume accommodation means to adjust the fuel electrode side gas supply volume to said fuel electrode side stream way was established.
[0002]
[Description of the Prior Art] This fuel cell is juxtaposed in the condition of equipping an oxygen pole side with an oxygen pole side stream way for the plurality of the cel which equipped the field of another side with the fuel electrode for the oxygen pole in preparation for one field of an electrolyte layer, and equipping a fuel electrode side with a fuel electrode side stream way. Generated output is outputted from the cel aggregate by carrying out conduction of the fuel electrode side gas which constitutes the cel aggregate, and is made to carry out conduction of the oxygen pole side gas which contains oxygen on an oxygen pole side stream way, and contains hydrogen on a fuel electrode side stream way, and making it generate electricity in each cel.
[0003] Conventionally, according to the generation-of-electrical-energy current of the cel aggregate, the fuel electrode side gas supply volume to a fuel electrode side stream way is beforehand set up as setting fuel electrode side gas supply volume so that a generation-of-electrical-energy current increases, and gas supply volume may increase, the generation-of-electrical-energy current of the cel aggregate was detected, and it constituted so that it might become the setting fuel electrode side gas supply volume according to the detection generation-of-electrical-energy current, and a fuel electrode side gas-supply-volume accommodation means might be controlled by the control means.
[0004]
[Problem(s) to be Solved by the Invention] By the way, although generating efficiency becomes high so that it is high, if the fuel utilization rate shown by the amount of the hydrogen to the whole quantity of the hydrogen supplied to the cel used at the reaction being comparatively alike becomes high too much, the problem that the generation-of-electrical-energy engine performance of a cel deteriorates will arise. For example, in the cel of the solid oxide type using a solid electrolyte layer, although nickel and the cermet of YSZ (Y2 O3 stabilization ZrO2) are used for a fuel electrode, if a fuel utilization rate becomes high too much, since a fuel electrode will oxidize and a microstructure will change, the generation-of-electrical-energy engine performance of a cel deteriorates.
[0005] On the other hand, operation time may follow a fuel cell on passing, and the phenomenon (it may be hereafter indicated as an oxygen leak) in which oxygen content gas leaks from an oxygen pole side to a fuel electrode side in a cel may happen.
[0006] In the cel to which oxygen leakage took place, the hydrogen content in the fuel electrode side gas which carries out conduction of the fuel electrode side stream way becomes low. Therefore, when adjusting uniquely so that it may become the fuel electrode side gas supply volume to fuel electrode side stream way setting-fuel

electrode side gas supply volume according to a detection generation-of-electrical-energy current like before, in the cel to which oxygen leakage took place, a fuel utilization rate will become higher than initial setting. Then, setting fuel electrode side gas supply volume looked at allowances beforehand so that it might not become high even to extent in which a cel deteriorates [the fuel utilization rate] even if oxygen leakage takes place to some cels in connection with the operation passage of time conventionally and a fuel utilization rate becomes high, and it had set up more mostly. Therefore, there was a problem that generating efficiency was low, in the conventional fuel cell.

[0007] This invention is made in view of this actual condition, and the purpose is in offering the fuel cell which may improve generating efficiency, controlling degradation of the generation-of-electrical-energy engine performance of a cel.

[0008]

[Means for Solving the Problem] [Invention according to claim 1] The oxygen density in the fuel electrode side gas by which the description configuration according to claim 1 carries out conduction of the part for the downstream in said fuel electrode side stream way, Or so that a detection oxygen density becomes high based on the detection oxygen density of an oxygen density detection means to detect the oxygen density in the discharged fuel electrode side gas, and its oxygen density detection means, from said fuel electrode side stream way and fuel electrode side gas supply volume may increase It is in the control means which controls said fuel electrode side gas-supply-volume accommodation means being established. The oxygen density in the fuel electrode side gas which will carry out conduction of the part for the downstream in a fuel electrode side stream way if oxygen leakage takes place in some cels according to the description configuration according to claim 1, Or since the oxygen density in the fuel electrode side gas discharged from the fuel electrode side stream way becomes high, Since it is adjusted so that fuel electrode side gas supply volume may increase, a fuel electrode side gas-supply-volume accommodation means may be controlled by the control means and a fuel utilization rate may become low by it, when the detection oxygen density of an oxygen density detection means becomes high, degradation of the cel resulting from oxygen leakage can be prevented. That is, according to the generation-of-electrical-energy current, setting fuel electrode side gas supply volume is set up, beforehand, if it is made to carry out increase and decrease of the setting fuel electrode side gas supply volume according to a detection generation-of-electrical-energy current of amendment according to a detection oxygen density, it is not necessary to make setting fuel electrode side gas supply volume into more values which looked at the conventional ****** allowances, and it can set up in the range which does not degrade a cel as few as possible. Therefore, controlling degradation of the generation-of-electrical-energy engine performance of a cel, it becomes possible to operate by the fuel utilization rate higher than before, and generating efficiency could be improved.

[0009] [Invention according to claim 2] the description configuration according to claim 2 The cel aggregate which said two or more cels were juxtaposed in the oxygen pole side stream way in the condition of equipping said fuel electrode side with a fuel electrode side stream way in preparation for said oxygen pole side, and was constituted That more than one are prepared and the fuel electrode side gas supply volume to said fuel electrode side stream way should be adjusted for said every cel aggregate Said fuel gas amount-of-supply accommodation means is established to said each of cel aggregate, and said oxygen density detection means is established to said each of cel aggregate. Said control means It is in being constituted for said every cel aggregate, so that control of said fuel electrode side gas-supply-volume accommodation means based on the detection oxygen density of said oxygen density detection means may be performed. Since according to the description configuration according to claim 2 two or more cel aggregates are constituted and control of the fuel electrode side gas-supply-volume accommodation means based on the detection oxygen density of an oxygen density detection means is performed for every cel aggregate using two or more cels which constitute a fuel cell, it can be made to operate according to a high fuel utilization rate as much as possible for every cel aggregate in the condition of controlling degradation of the generation-of-electrical-energy engine performance of a cel. Therefore, all the cels that constitute a fuel cell were constituted in the one cel aggregate, and generating efficiency could be improved further, controlling degradation of the generation-of-electrical-energy engine performance of a cel, since the fuel utilization rate as the whole fuel cell could be effectively made high and it operated with the one cel aggregate compared with the case where control of the fuel electrode side gas-supply-volume accommodation means based on the detection oxygen density of an oxygen density detection means is

performed.
[0010]
[Embodiment of the Invention] The [1st operation gestalt] Based on drawing 1 thru/or drawing 4 , the case where the gestalt of operation of the 1st of this invention is applied to the fuel cell using a cylindrical solid oxide type cel is explained hereafter. As shown in drawing 1 , a fuel cell forms the fuel cell generation-of-electrical-energy section EG equipped with the one cel aggregate NC. Supply the fuel gas which contains hydrogen as fuel electrode side gas through the fuel gas supply way 1 in the cel aggregate NC, and the air from a blower 3 is supplied to a list as oxygen pole side gas through the air supply way 2. It constitutes from a power output way 4 so that the direct current power generated with the cel aggregate NC may be outputted.
[0011] The fuel gas amount-of-supply control valve 5 which adjusts the fuel gas amount of supply to the cel aggregate NC is formed in the fuel gas supply way 1. In the air supply way 2 The amount control valve 6 of air supply which adjusts the amount of air supply to the cel aggregate NC is formed. In the power output way 4 The current detector 7 which detects the generation-of-electrical-energy current from the cel aggregate NC is formed, and the control section 8 which controls fuel gas amount-of-supply control valve 5 and amount control valve of air supply 6 each is formed based on the detection generation-of-electrical-energy current of the current detector 7.
[0012] Based on drawing 2 and drawing 3 , explanation is added about the generation-of-electrical-energy section EG. The cel C of a fuel cell forms the solid electrolyte layer 11 and interconnector 14 in the periphery section of the oxygen pole tube 12 by using as a structure base material the oxygen pole 12 (an oxygen pole tube being called hereafter) of the shape of a cylinder which blockaded the end, forms a fuel electrode 13 in the periphery section of the solid electrolyte layer 11 in the state of interconnector 14 and non-contact, and has formed it in cylindrical [which the end side blockaded]. The interior of a cylinder of Cel C is operated as an oxygen pole side stream way s, and where the air installation tubing 15 which supplies air to the oxygen pole side stream way s is inserted in the interior of a cylinder, it has prepared.
[0013] Interconnector 14 is formed in the periphery section of the oxygen pole tube 12 at the elongated shape which meets in the direction of an axis, and the solid electrolyte layer 11 is formed in the remaining part in which the interconnector 14 in the periphery section of the oxygen pole tube 12 was formed.
[0014] the solid electrolyte layer 11 -- YSZ and the oxygen pole tube 12 -- LaMnO3 and a fuel electrode 13 -- nickel and ZrO2 a cermet and interconnector 14 -- LaCrO3 from -- it changes, respectively.
[0015] With the septa 17 and 18 of two sheets, and the porous distributor 19 of one sheet, partition formation has been carried out so that the air supply room 20, a combustion chamber 21, a generator room 22, and the fuel gas supply room 23 may be stood in a line toward the bottom for the interior of a box 16 in order of a publication from a top.
[0016] In and the condition of supporting by the septum 18 which divides the combustion chamber 21 and generator room 22 in the condition of having made the combustion chamber 21 facing the opening edge of each oxygen pole tube 12 for two or more cylindrical cels C The cel C located in a line in the vertical direction in drawing 3 in a generator room 22 while separating spacing mutually and juxtaposing in the shape of a grid By preparing between the adjoining cels C in the condition of contacting the flexibility electric conduction material 24 formed in the condition of permitting gaseous conduction to fuel electrode 13 adjoining comrades Between the adjoining cels C, by preparing in the condition of contacting the flexibility electric conduction material 24 to adjoining interconnector 14 and an adjoining fuel electrode 13, series connection of the cel C which carries out parallel connection electrically and is located in a line with a list at a longitudinal direction is carried out electrically, and it has formed the cel aggregate NC. 18h of many air holes which open a combustion chamber 21 and a generator room 22 for free passage is formed in the septum 18 which divides a combustion chamber 21 and a generator room 22.
[0017] In the end side of the cel train located in a line in the direction of series connection, in the condition of connecting with the fuel electrode 13 of each cel C of the edge by the flexibility electric conduction material 24 at a conductive state To the other end side of the cel train which forms a collecting electrode plate 25 and is located in a line in the direction of series connection A collecting electrode plate 25 is formed, and the collecting electrode plate 25 of these pairs constitutes from the condition of connecting with a conductive state by each interconnector 14 and flexibility electric conduction material 24 of Cel C of the edge so that generated output may be taken out from the cel aggregate NC. The flexibility electric conduction material 24 consists of

the felt-like material of nickel.
[0018] The air installation tubing 15 of each cel C penetrates the septum 17 which divides the air supply room 20 and a combustion chamber 21, and it provides it so that an opening edge may be located in the air supply room 20. And the fuel gas supply way 1 is connected to the fuel gas supply room 23, the air supply way 2 is connected to the air supply room 20, and the exhaust gas way 26 is connected to the combustion chamber 21. The power output way 4 is connected to the collecting electrode plate 25 of a pair.
[0019] Therefore, the fuel gas supplied to the fuel gas supply room 23 from the fuel gas supply way 1 flows into a generator room 22 in the condition of being distributed by the distributor 19, it is in the condition of contacting the fuel electrode 13 of each cel C in between the cels C in a generator room 22, and it flows toward the direction of a combustion chamber 21, passes 18h of air holes of a septum 18, and flows into a combustion chamber 21. Therefore, the inside of a generator room 22 functions as a fuel electrode side stream way f, sets in a generator room 22, and the edge by the side of a combustion chamber 21 is equivalent to a part for the downstream in the fuel electrode side stream way f. On the other hand, through the air installation tubing 15 of each cel C, the air supplied to the air supply room 20 from the air supply way 2 flows into the oxygen pole side stream way s inside the cylinder of each cel C, flows in the condition of contacting the oxygen pole 12 in the oxygen pole side stream way s, and flows into a combustion chamber 21 from a cylinder opening edge. And the fuel gas and air which flowed into the combustion chamber 21 burn in a combustion chamber 21, and the combustion gas is discharged through the exhaust gas way 26. The power generated with the cel aggregate NC is outputted through the power output way 4.
[0020] It sets to this invention and oxygen sensor S as an oxygen density detection means to detect the oxygen density in the fuel gas which carries out conduction of the edge the downstream part in the fuel electrode side stream way f and by the side of the combustion chamber 21 in a generator room 22 if it puts in another way is prepared.
[0021] Oxygen sensor S uses as a structure base material the sensor tube 31 made from YSZ which the end blockaded, as shown in drawing 4 . While attaching the porous inside electrode 32 to the lock out edge inner skin of the sensor tube 31, attaching the porous ground electrode 33 to a lock out edge peripheral face and forming a detection section Temperature sensor 35 each which is detected in the air supply tubing 34 which supplies air in the sensor tube 31, and the sensor tube 31 is inserted into the sensor tube 31, and it constitutes. Furthermore, the lead wire 36 for electrical-potential-difference ejection is connected to an electrode 32 and 33 each. In addition, the inside electrode 32 consists of platinum and a ground electrode 33 consists of nickel and the cermet of YSZ.
[0022] And as shown in drawing 2 , it has prepared so that the detection section of the lock out edge of the sensor tube 31 may be located in the downstream part in the fuel electrode side stream way f and the opening edge of the air supply tubing 34 may be located in the air supply room 20 in oxygen sensor S constituted as mentioned above.
[0023] If YSZ becomes an elevated temperature more than 500-degreeC, it will serve as an oxygen ion conductor, but the operating temperature of the fuel cell of a solid oxide type is about [800-1000 degrees] C, and since the sensor tube 31 will be heated by the elevated temperature comparable as said operating temperature when oxygen sensor S is prepared as mentioned above, YSZ which constitutes the sensor tube 31 serves as an oxygen ion conductor. And since the part to which the inside of the sensor tube 31 became an air ambient atmosphere, and the ground electrode 33 besides the sensor tube 31 was attached is exposed to the fuel gas which flows the downstream part in the fuel electrode side stream way f, oxygen tension will differ within and without a tube, and this system serves as an oxygen concentration cell, and produces electromotive force between two electrodes 32 and 33. Since the inside of the sensor tube 31 is air whose oxygen density is known, it can ask for the oxygen density in the fuel gas which flows the downstream part in the fuel electrode side stream way f with two electrodes 32 and the electromotive force generated among 33. In addition, in asking for the oxygen density in fuel gas in oxygen sensor S, temperature compensation is carried out with the detection temperature of a temperature sensor 35, and it normalizes, and asks.
[0024] Next, explanation is added about the control action of a control section 8. A control section 8 controls fuel gas amount-of-supply control valve 5 and amount control valve of air supply 6 each based on the detection information on current detector 7 and oxygen sensor S each to be shown in drawing 1 . According to the generation-of-electrical-energy current of the cel aggregate NC, it has set up, respectively by making into the

amount of setting air supply the amount of air supply per [which is beforehand supplied on the air supply way 2 by making into the setting fuel gas amount of supply the fuel gas amount of supply per / which is supplied on the fuel gas supply way 1 / unit time amount] unit time amount. The condition, i.e., the detection oxygen density of oxygen sensor S, that the setting fuel gas amount of supply does not have the leakage of the air from the oxygen pole 12 side to a fuel electrode 13 side (namely, oxygen leakage) for example, in the cel C is a zero state, and the fuel utilization rate in each cel C is set up so that 85% can be maintained.

[0025] When the detection oxygen density of oxygen sensor S is zero, a control section 8 specifically So that it may adjust to the setting fuel electrode side gas supply volume according to the detection generation-of-electrical-energy current of the current detector 7 If the fuel gas amount-of-supply control valve 5 is controlled and the detection oxygen density of oxygen sensor S becomes high from zero The fuel gas amount-of-supply control valve 5 is controlled to amend the setting fuel electrode side gas supply volume according to the detection generation-of-electrical-energy current of the current detector 7 so that the detection oxygen density becomes high and the amount of amendments may increase, and to adjust it to the amended setting fuel electrode side gas supply volume according to a detection oxygen density. For example, if the detection oxygen density of oxygen sensor S becomes 5%, it will amend so that said setting fuel electrode side gas supply volume may be made [many] 5%. Moreover, the amount control valve 6 of air supply is controlled to adjust in the amount of setting air supply according to the detection generation-of-electrical-energy current of the current detector 7.

[0026] Therefore, since it will be adjusted so that the detection oxygen density of oxygen sensor S becomes higher than zero, a detection oxygen density becomes high according to the detection oxygen density, and the fuel gas amount of supply may increase if oxygen leakage occurs in a part of cel C in a generator room 22, the cel C to which oxygen leakage took place does not deteriorate. Therefore, it can be set as values fewer than before, preventing degradation of the generation-of-electrical-energy engine performance of Cel C, since it is not necessary to make setting fuel electrode side gas supply volume into more values which looked at the conventional ****** allowances.

[0027] Hereafter, although each 2nd [of this invention] and 3rd operation gestalten are explained, explanation is omitted by attaching the same sign, in order to avoid duplication explanation about the same component as the 1st operation gestalt, or the component which has the same operation, and a different configuration from the 1st operation gestalt is mainly explained.

[0028] The [2nd operation gestalt] Based on drawing 5 and drawing 6 , the case where the gestalt of operation of the 2nd of this invention is applied to the fuel cell using a cylindrical solid oxide type cel is explained hereafter. It constitutes so that the direct current power which forms the fuel cell generation-of-electrical-energy section EG with which the fuel cell was equipped with two or more cel aggregate NC as shown in drawing 5 , supplies fuel gas according to an individual through the fuel gas supply way 1 to each cel aggregate NC, supplies air to a list through the air-supply way 2, and is outputted through the power output way 4 from each cel aggregate NC may be made to join the unification output way 9 and it may output.

[0029] As shown in drawing 6 , the generation-of-electrical-energy section EG juxtaposes the plurality of the box 16 equipped with the cel aggregate NC etc. like the 1st operation gestalt, and is constituted. The fuel gas supply way 1 and the air supply way 2 are formed like the 1st operation gestalt for every cel aggregate NC, and the power output way 4 as well as the 1st operation gestalt is established in the list for every cel aggregate NC.

[0030] The amount control valve 6 of air supply is formed in each air supply way 2, and the current detector 7 is formed for the fuel gas amount-of-supply control valve 5 in each power output way 4 on each fuel gas supply way 1, respectively. Moreover, the same oxygen sensor S as the 1st operation gestalt is prepared like the 1st operation gestalt to each cel aggregate NC.

[0031] The control section 8 is constituted so that control of the amount control valve 6 of air supply based on the detection generation-of-electrical-energy current of the current detector 7 may be performed like the 1st operation gestalt for every cel aggregate NC in the control of the fuel gas amount-of-supply control valve 5 based on the detection generation-of-electrical-energy current of the current detector 7, and each detection oxygen density of oxygen sensor S, and a list. Therefore, it can be made to operate according to a high fuel utilization rate as much as possible for every cel aggregate NC in the condition of controlling degradation of the generation-of-electrical-energy engine performance of Cel C.

[0032] The [3rd operation gestalt] Based on drawing 7 thru/or drawing 10 , the case where the gestalt of

operation of the 3rd of this invention is applied to the fuel cell using the solid oxide type cel of a monotonous mold is explained hereafter. As shown in drawing 7 , in the 3rd operation gestalt, it constitutes like the 1st operation gestalt except the fuel cell generation-of-electrical-energy section EG.

[0033] Hereafter, based on drawing 8 thru/or drawing 10 , the fuel cell generation-of-electrical-energy section EG is explained. As shown in drawing 8 , Cel C is in the condition that a flat-surface configuration forms electrolyte layer outcrop 41a covering a side edge overall length in one field of the rectangle tabular solid electrolyte layer 41 at each side edge of the pair in the solid electrolyte layer 41 which faces each other. the shape of film, and the tabular oxygen pole 42 -- one ---like -- attaching -- and the field of another side -- the shape of film, and the tabular fuel electrode 43 -- the whole surface -- or it attaches in one over the whole surface mostly, and has formed in rectangle tabular.

[0034] And that the oxygen pole side stream way s should be formed, the conductive separator 44 is attached and the rectangle tabular cel Cs with a separator is formed in the oxygen pole 42 side in Cel C. If explanation is added, the conductive separator 44 is really formed with the conductive ingredient by the condition of having two or more protruding line section 44c located between plate-like part 44a, band-like height 44b of the pair located in the both ends of the plate-like part 44a, respectively, and band-like height 44b of these pairs. the conductive separator 44 -- two or more protruding line section 44c -- the condition that each contacts the oxygen pole 42 -- band-like height 44b of a pair -- each -- both electrolytes layer outcrop 41a -- the cel Cs with a separator is formed by being alike, respectively and sticking.

[0035] And while connecting the oxygen pole 42 and the conductive separator 44 to a conductive state, the oxygen pole side stream way s equipped with Opening so between the oxygen pole 42 and the conductive separator 44 in the cel periphery part corresponding to the side of a pair where one side of the four sides which form the cel periphery in the cel Cs with a separator counters is formed. That is, the cel C with a separator is constituted so that the periphery part of the pair with which the cel periphery part of the pair which while counters in a cel with a separator turns into an opening periphery part which the oxygen pole side stream way s opened and which another side faces with the conductive separator 44 may turn into a lock out periphery part which the oxygen pole side stream way s closed.

[0036] the solid electrolyte layer 41 -- YSZ and the oxygen pole 42 -- LaMnO3 and a fuel electrode 43 -- nickel and ZrO2 a cermet and the conductive separator 44 -- LaCrO3 from -- it changes, respectively.

[0037] And as shown in drawing 9 and drawing 10 , that the fuel electrode side stream way f should be formed for two or more cels Cs with a separator while it is mutual, spacing is separated, it juxtaposes in the thickness direction, and the cel aggregate NC is formed. When explanation is added, while making each ** stick the insinuating remark member 45 of a prismatic form long pair to each side face of the lock out periphery part of the pair in the cel Cs with a separator from the cel Cs with a separator by the same thickness as the cel Cs with a separator The spacing member 46 of a prismatic form long pair from the cel Cs with a separator in the condition of making it sticking to the insinuating remark member 45 of a pair in piles in the shape of parallel crosses While sticking each ** into the opening periphery part of the pair in the cel Cs with a separator and carrying the cel Cs with a separator on the spacing member 46 of these pairs further In the condition of piling up the insinuating remark member 45 of a pair in the shape of parallel crosses, by repeating sticking each ** on the side face of the lock out periphery part of the pair of the cel Cs with a separator Spacing is separated and juxtaposed in the condition of forming the fuel electrode side stream way f into which both sides were divided for the plurality of the cel Cs with a separator by the spacing member 46 of a pair while it was mutual, and the cel aggregate NC is formed. And the opening fo of the fuel electrode side stream way f is formed in each lateral portion in the cel aggregate NC which while counters by the spacing members 46 and 46 of a pair, and two insinuating remark members 45 and 45 which adjoin in the direction of a cel list.

[0038] In addition, between the cels Cs with a separator, it is filled up with the flexibility electric conduction material 47 formed in the condition of permitting gaseous conduction, and the cel CS with a ****** separator is electrically connected by series connection by the flexibility electric conduction material 47. The flexibility electric conduction material 47 is formed in the felt-like material of nickel.

[0039] In the cel aggregate NC, a collecting electrode plate 48 is formed in the direction both ends of a cel list of the cel Cs with a separator in the condition of connecting with the cel Cs with a separator of each edge at a conductive state, and it constitutes so that generated output may be taken out from the cel aggregate NC with the collecting electrode plate 48 of these pairs.

[0040] As shown in drawing 10 , attach a wind channel 49 to each of four side faces in the cel aggregate NC constituted as mentioned above, and one interior is made into the fuel gas supply room 50 among the wind tunnels 49 of the pair of the direction which the opening fo of the fuel electrode side stream way f overlooks. The interior of another side is made into the fuel gas discharge room 51, and using one interior as the air supply room 52 among the wind tunnels 49 of the pair of the direction which the opening so of the oxygen pole side stream way s overlooks, by making the interior of another side into the air discharge room 53, it constitutes so that it may use, respectively.
[0041] and it is shown in drawing 7 and drawing 10 -- as -- the fuel gas supply room 50 -- the fuel gas supply way 1 -- the air supply way 2 is connected to the air supply room 52, and the air exhaust passage 55 is connected to the fuel gas discharge room 51 for the fuel gas exhaust passage 54 at the air discharge room 53, respectively. The amount control valve 6 of air supply is formed in the fuel gas amount-of-supply control valve 5 and the air supply way 2 like the 1st operation gestalt on the fuel gas supply way 1, respectively. It connects with the collecting electrode plate 48 of a pair, and the power output way 4 has formed the current detector 7 in the power output way 4.
[0042] Therefore, the fuel gas supplied to the fuel gas supply room 50 from the fuel gas supply way 1 flows into each fuel electrode side stream way f from Opening fo, flows in the condition of contacting a fuel electrode 43 in each fuel electrode side stream way f, flows out of the opening fo of the opposite side in the fuel gas discharge room 51, and is discharged through the fuel gas exhaust passage 54. On the other hand, the air supplied to the air supply room 52 from the air supply way 2 flows into each oxygen pole side stream way s from Opening so, flows in the condition of contacting the oxygen pole 42 in each oxygen pole side stream way s, flows out of the opening so of the opposite side in the air discharge room 53, and is discharged through the air exhaust passage 55. And the power generated with the cel aggregate NC is outputted through the power output way 4.
[0043] The same oxygen sensor S as the 1st operation gestalt is prepared so that the detection section of the lock out edge of the sensor tube 31 may be located in the fuel gas discharge room 51 and the opening edge of the air supply tubing 34 may be located outside the fuel gas discharge room 51, and it constitutes from oxygen sensor S so that the oxygen density in the fuel gas in the fuel gas discharge room 51 and the fuel gas discharged from the fuel electrode side stream way f when putting in another way may be detected. In addition, since the fuel gas of temperature equivalent to fuel cell operating temperature is discharged from each fuel electrode side stream way f in the fuel gas discharge room 51, the inside of the fuel gas discharge room 51 serves as sufficient elevated temperature for YSZ of oxygen sensor S to serve as an oxygen ion conductor.
[0044] A control section 8 performs control of the amount control valve 6 of air supply based on the detection generation-of-electrical-energy current of the current detector 7 like the 1st operation gestalt in the control of the fuel gas amount-of-supply control valve 5 based on the detection generation-of-electrical-energy current of the current detector 7, and each detection oxygen density of oxygen sensor S, and a list.
[0045] [Another operation gestalt] Another operation gestalt is explained below.
(**) In each above 1st and 2nd operation gestalten, although illustrated about the case where one oxygen sensor S is prepared, to the one cel aggregate NC, it may be made to distribute and you may prepare to the one cel aggregate NC, so that the oxygen density of each part of the downstream [S / two or more / oxygen sensor] part in the fuel electrode side stream way f can be detected. In this case, if it constitutes so that increase accommodation of the fuel gas amount of supply may be performed based on the highest detection oxygen density, since the oxygen leakage of Cel C can be discovered quickly and a cure can be taken quickly, degradation of the generation-of-electrical-energy engine performance of Cel C can be prevented much more effectively.
[0046] (**) It may set in the 3rd operation gestalt, and you may prepare so that the oxygen density of the fuel gas which carries out conduction of the downstream [S / oxygen sensor] part in the fuel electrode side stream way f may be detected.
[0047] (**) In the above-mentioned operation gestalt, the detection oxygen density of oxygen sensor S is a zero state, and the setting fuel gas amount of supply was illustrated about the case where it sets up so that the fuel utilization rate in each cel C can be maintained to the set point (for example, 85%). It may replace with this, and you may set up so that the detection oxygen density of oxygen sensor S can maintain a fuel utilization rate [in / for the setting fuel gas amount of supply / each cel C] to the set point in the condition of a setting oxygen

density higher than zero. In this case, according to a detection oxygen density, when a detection oxygen density is lower than said setting oxygen density, reduction amendment of the setting fuel electrode side gas supply volume according to the detection generation-of-electrical-energy current of the current detector 7 will be carried out so that that detection oxygen density becomes low, and the amount of reduction amendments may increase.

[0048] (**) Since carrying out reforming processing of the original fuel gas of hydrocarbon systems, such as methane, into the fuel electrode side stream way f at the fuel gas which contains hydrogen gas using a steam, and the so-called internal reforming are possible, you may make it supply the mixed gas of original fuel gas and a steam from the fuel gas supply way 1 in the fuel cell of the solid oxide type illustrated in the above-mentioned operation gestalt. In this case, although the amount of supply of original fuel gas will be adjusted by the fuel gas amount-of-supply control valve 5, the amount of supply of fuel gas will be adjusted as a result. Therefore, it shall include adjusting the amount of supply of original fuel gas by the fuel gas amount-of-supply control valve 5 in adjusting the amount of supply of fuel gas by the fuel gas amount-of-supply control valve 5.

[0049] (**) The concrete configuration of oxygen sensor S is not limited to the configuration illustrated in the above-mentioned operation gestalt. For example, an electrical potential difference may be impressed to the both sides of YSZ, and you may constitute so that an oxygen density may be detected based on the current value, so that the current which uses oxygen ion as a carrier according to a pumping operation may flow YSZ.

[0050] (**) This invention is applicable to various fuel cells, such as a phosphoric-acid mold and a solid-state macromolecule mold, in addition to the fuel cell of the solid oxide type illustrated in the above-mentioned operation gestalt. However, since each operating temperature is not the elevated temperature from which YSZ serves as an oxygen ion conductor, the fuel cell of a phosphoric-acid mold or a solid-state macromolecule mold forms the heater for heating YSZ so that it may become an oxygen ion conductor in oxygen sensor S.

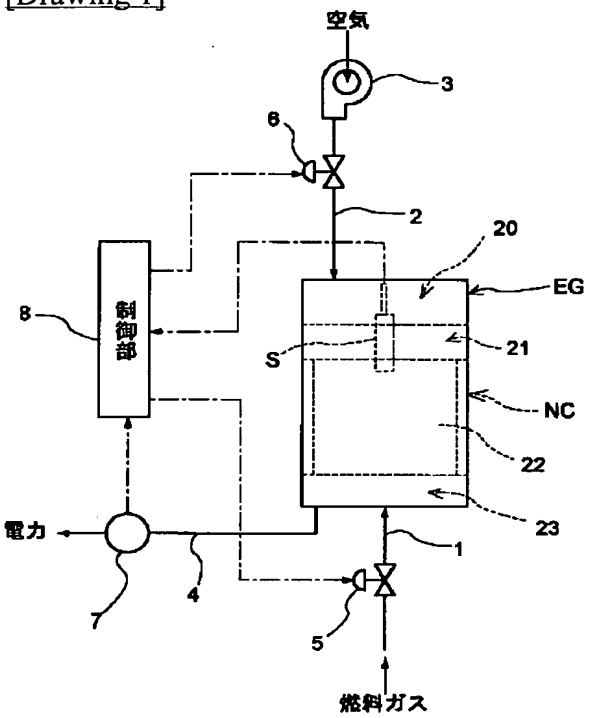
[Translation done.]

* NOTICES *

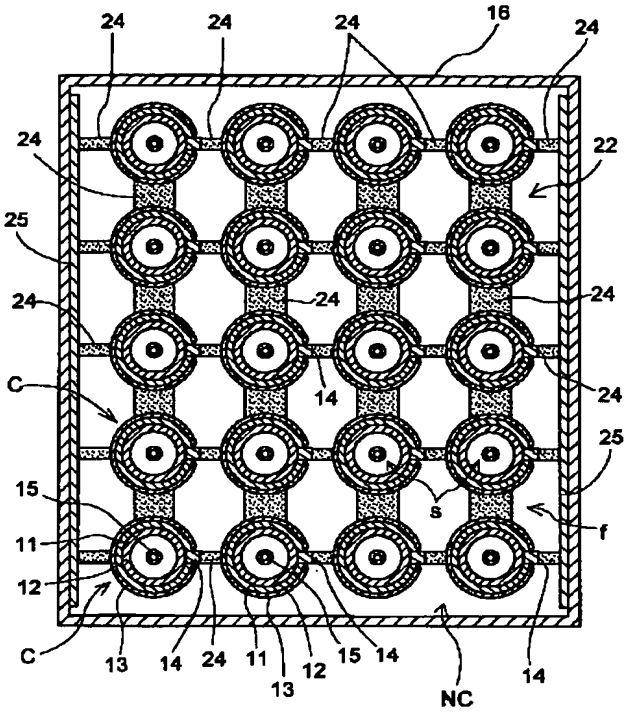
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

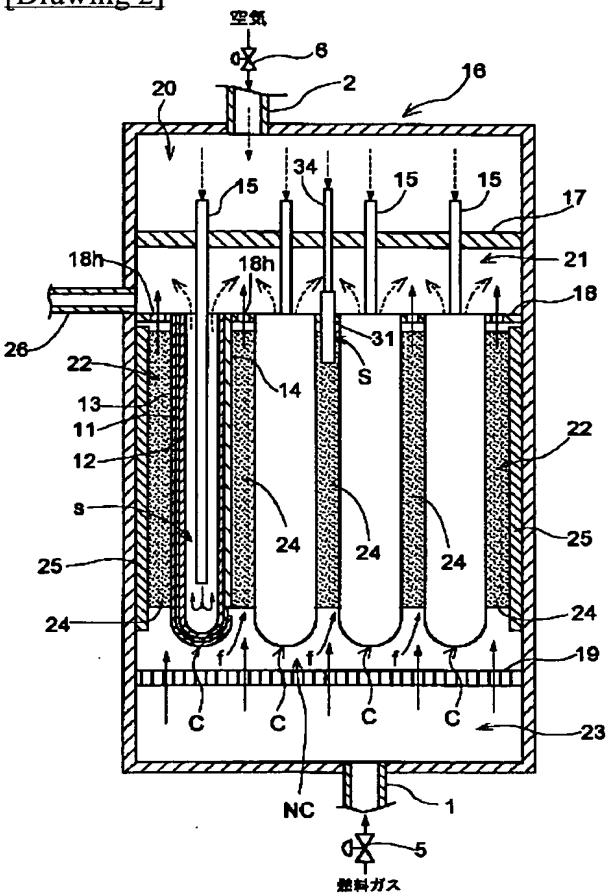
[Drawing 1]



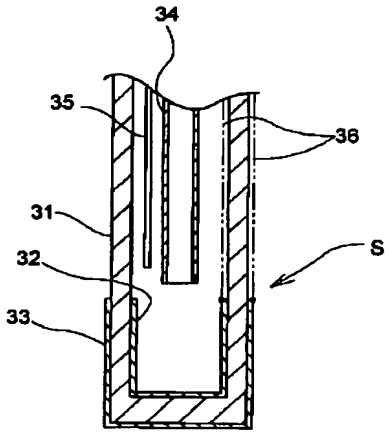
[Drawing 3]



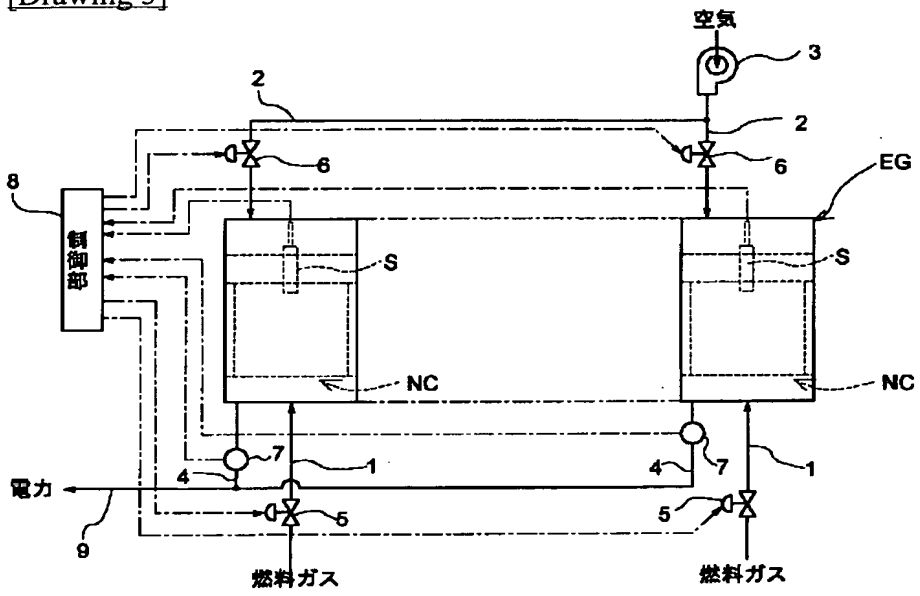
[Drawing 2]



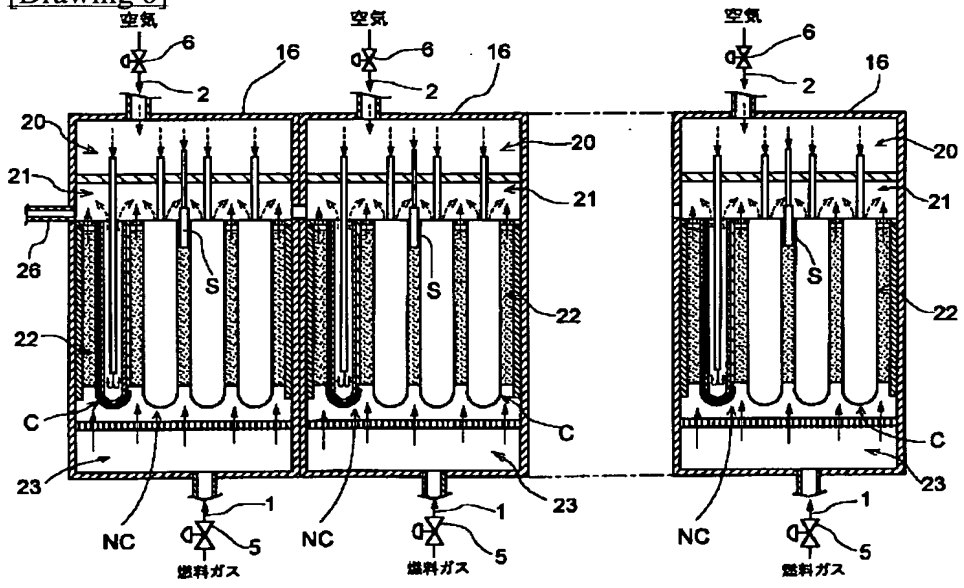
[Drawing 4]



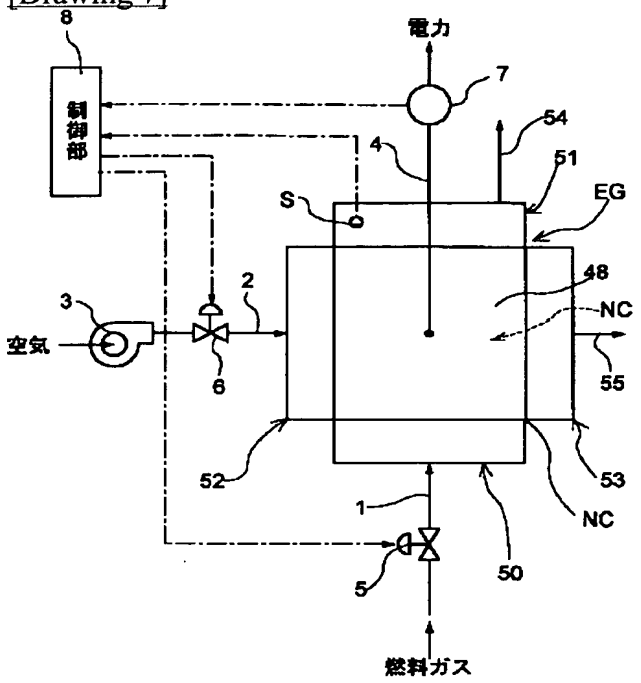
[Drawing 5]



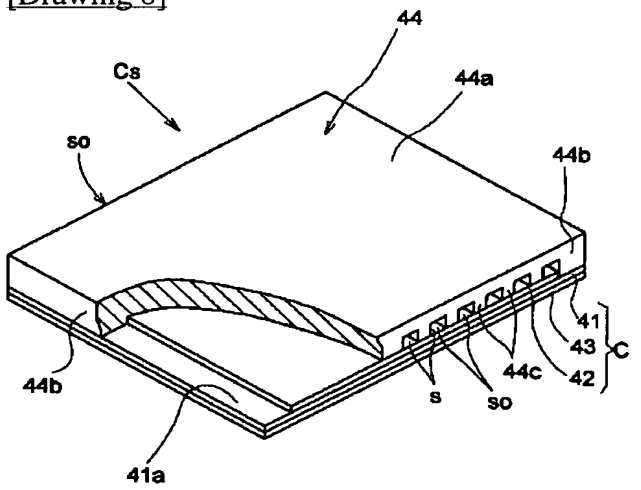
[Drawing 6]



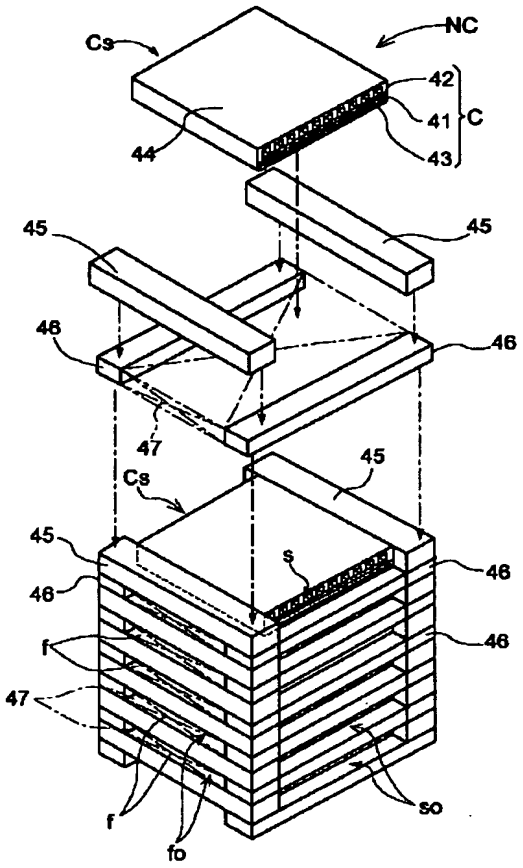
[Drawing 7]



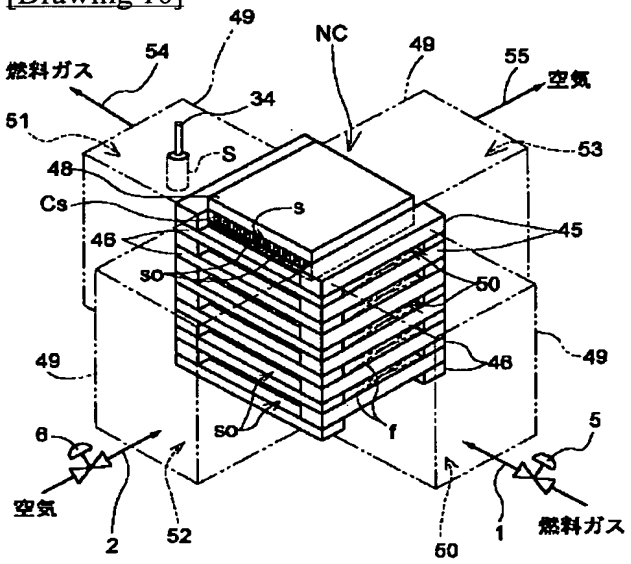
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]

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